RHYTHMICAL ACTIVITY IN INFUSORIA.

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While much in the behavior of the infusoria comes under the head of direct responses to external stimuli, there is, in many forms, an extraordinary amount of activity which cannot be traced to any outside cause. In addition to those forms which keep up a continuous swimming with never-flagging energy, there are several infusorians which perform movements of a more or less regular rhythm. These are analogous to such rhythmical movements as the beating of the heart of higher animals, or the rhythmical pulsations of the swimming of a jelly-fish. They are more automatic than the latter, and are, perhaps, more closely comparable to the regular pulsations, which, under certain conditions, are performed by some species of jelly-fish after removal of the nerve ring and marginal sense organs.

More or less regular and apparently spontaneous movements have been noted in a few species (*Stentor*, *Vorticella*) by various writers, but the subject has received scarcely more than a passing mention. My attention was called to this feature of the behavior of certain infusoria in some studies recently made on the behavior of *Loxophyllum meleagris*, and I was led to look for similar phenomena in other forms. Observations were made on the following species :

Loxophyllum meleagris. — *Loxophyllum* commonly moves about on some solid object by extending the body, gliding forward a short distance, then swimming backward, turning toward the oral side and then going forward again. The changes in the direction of movement are not due to any obstacles encountered ; they occur in much the same way when there are no objects in its course. The organism frequently keeps up this kind of movement for a long time in very nearly the same locality. The body is always narrowed in swimming forward, and always widened in swimming backward, thus showing a constant correlation of the contractile activities with the direction of the ciliary beat. If the body is cut in two, the pieces will undergo the same rhyth-

mical back-and-forth movements. Even very small pieces, less than one sixteenth of the body, show the same regular rhythm and the same correlation of ciliary and contractile activity.

Dileptus gigas. — *Dileptus gigas* commonly adheres to the surface of some solid object and waves its long proboscis-like anterior extremity or neck about in an anti-clockwise direction. The surface of the body is quite sticky, as is shown by the fact that it adheres readily to any object brought in contact with it. The slender extremity in its movement about in a circle executes many twists and curls in more or less irregular ways. These movements may be very vigorous or they may be very slow, but they scarcely ever entirely cease. The slender neck is very extensile and may be elongated to three or more times its length when in a contracted state.

Dileptus often executes short forward and backward movements at tolerably regular intervals. During its movement forward the body elongates, and while gliding backward it widens, showing the same correlation of contractility with the direction of the beat of the cilia that occurs in *Loxophyllum meleagris*. The backward and forward excursions vary exceedingly in length. Frequently they are exceedingly short. Even when the organism remains attached in one place the body undergoes more or less regular elongations and contractions while waving about the anterior extremity. There is a rhythm here much as in the preceding species occurring quite independently of external stimulation. The posterior third of the body when severed from the rest still undergoes elongations and contractions, although in a somewhat lessened degree. In larger pieces the rhythm of movement is more manifest.

Lachrymaria olor. — This interesting species resembles *Dileptus gigas* in its general behavior as well as its external form. Its long flexible neck is kept continually waving about, but the extensions and contractions of its body do not occur so regularly as in the preceding species.

Vorticella. — *Vorticella* frequently shows quite regular rhythmic contractions without an apparent external cause. The peristome with its membranellæ is folded in and the stalk contracts into a spiral form. In a short time the spiral straightens out, the peri-

stome expands, and another contraction soon follows. Hodge and Acking found that the interval between successive contractions in *Vorticella* varied greatly. In one individual kept for a long time under continuous observation contractions occurred at one time about once in four seconds, at another once in eight seconds, and at various other intervals in different times. Sometimes there was no rhythmic contraction at all. The stimulus to the rhythmic contraction of the stalk apparently comes from the body, for the stalks which I have isolated showed no independent movements.

Stentor. — *Stentor cæruleus* when attached and extended sways about slowly in a circle. The swaying is a very regular movement and is not due to any evident external stimulus. It is a result of the contraction of the body instead of the action of cilia, as the stalk is bent successively in different directions. There is also a rhythmic movement executed by *Stentor roeselii* during the construction of its tube. This species after attaching itself alternately contracts and extends its body in a more or less regular manner while it is secreting the gelatinous substance of which its tube is formed. The swaying movements are not so pronounced as in the preceding species.

It is a noteworthy fact that rhythmical activities occur in those species which are either attached like *Stentor* and *Vorticella*, or which like *Loxophyllum*, *Dileptus* and *Lachrymaria* frequently remain for a long time near one spot. These forms do not have to wait for something to turn up, but are actively seeking for new stimulations, their rhythmical movements bringing them in a measure the advantages which in forms like *Paramœcium* are secured by almost continuous swimming.

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